NOAA WAVEWATCH III

NCEP's operational ocean wave model

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Outline

- ✔ What is a wave model ...
  (excerpts from the web page primer)
- ✔ NCEP ocean wave guidance
  - ➤ Guidance for NE.
  - ➤ WNA versus NAH models.
- ✔ Strong and weak point of new models
- ✔ Products
  - ➤ what
  - ➤ how to get
- ✔ The future.

Wind waves 1

- Wind waves are the waves at sea that are generated by local or distant winds. Waves generated locally are usually referred to as wind sea. Waves generated at distant locations in the past are referred to as swell.
- Wind waves range in wave height from negligible to 30m (100ft) and more, and in length (distance between consecutive waves) from centimeters to 1 km.
- Corresponding wave periods (i.e., the time it takes for two consecutive waves to pass a given location) range from less than 1 second to about 25s.

http://polar.ncep.noaa.gov/waves/pres/primer

Wind waves 2

- Although wind wave conditions generally change slowly, no two consecutive waves are identical. Furthermore, individual waves are so small that it would be practically impossible to predict every individual wave. Instead the wave field is described with average measures for wave heights.
- The commonly used wave height to describe the wave field is the significant wave height H_s, which is usually defined as the average wave height of the highest 33% of all individual waves. Because smaller waves are generally not seen against the background of the larger ones, this corresponds closely to the visually observed mean wave height.

primer

Wind waves 3

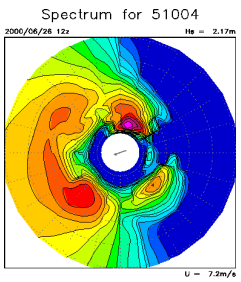
- Generally, it is assumed that individual wave heights can be described using a Rayleigh distribution. This implies that for a significant wave height H_s = 10m (33ft), one can expect :
  - ➢ 1 in 10 waves to be larger than 10.7m (36ft).
  - ➢ 1 in 100 waves to be larger than 15.1m (51ft).
  - ➢ 1 in 1000 waves to be larger than 18.6m (62ft).
- This implies that the largest individual wave that one might encounter in a storm is roughly twice as high as the significant wave height !
- In rapidly changing conditions the disparity between the significant wave height and the largest individual waves might even be larger.

primer

Wave spectra 1

In advanced wave observations and inside wave models, the wave field is not described with a single wave height, but with a so-called wave spectrum, which describes the distribution of wave energy over wave directions and frequencies at a fixed location.

A graphical representation of such a spectrum as can be found on the web page is shown here (buoy location 51004, SE of Hawaii).



primer

Wave spectra

The spectral plots from the wave model mostly give qualitative information. The corresponding quantitative information can be found in the bulletins.

A piece of such a bulletin is presented below. The first column gives date and hour, the second the overall wave height and number of identified individual wave fields. The next six columns (only two shown here) identify wave fields by height, period and direction.

```
Location : 51004      (17.40N 152.50W)
 Model    : NWW3 global 1x1.25 degr.
 Cycle    : 20000626 t00z
+-------+----------+-----------------+-------+
| day &  | Hst  n x |     Hs   Tp dir |     H |
|  hour  |  (m)  - - |    (m)  (s) (d) |   (m) |
+-------+----------+-----------------+-------+
| 25 12  |  1.9  7  |    1.0 17.5  19 |   1.0 |
| 25 13  |  1.9  7  |    1.0 17.6  19 |   1.0 |
| 25 14  |  1.9  6  |    1.1 17.6  19 |   0.9 |
```

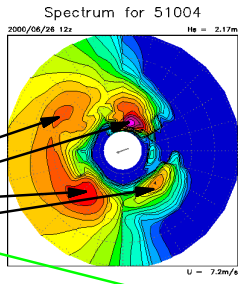
AWIPS : feet, dir. from

primer

Wave spectra

The info in the spectral plots and the bulletins can be combined as follows (*Hs* is significant wave height, *Tp* is peak or dominant period)

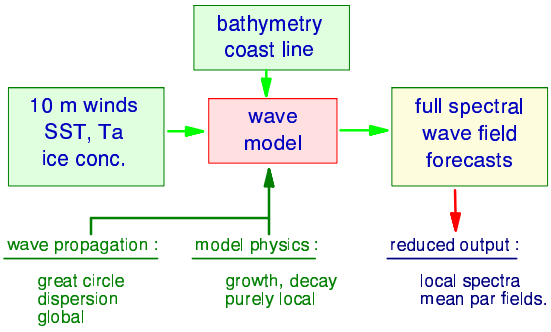
Hs = 0.7m, *Tp* = 6.6s
Hs = 1.4m, *Tp* = 15.9s
Hs = 1.4m, *Tp* = 7.0s
Hs = 0.3m, *Tp* = 9.9s




```
| 26 12 |  2.2  4 | 1.4 15.9  16 | 0.7  6.6 306 | 1.4  7.0 239 | 0.3  9.9 136 |
```

primer

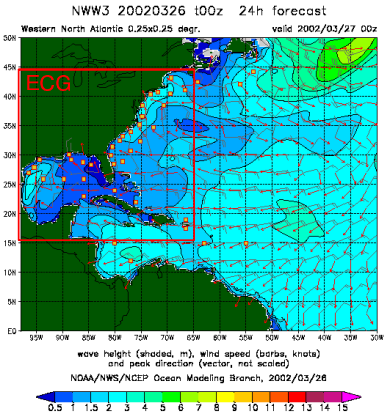
Numerical wave models



NCEP Guidance for NE

- NOAA WAVEWATCH III has replaced all previous operational wave models at NCEP by March 2000, upgraded to model version 2.22 Aug. 2002.
  - Global 1.25x1° NWW3 model (126h, GFS winds every 3 hours).
  - Western North Atlantic model (WNA, 0.25x0.25°, 126h, GFS winds every 3 hours).
  - Seasonal Hurricane version of WNA (NAH, 72h, GFS/GFDL winds every hour).
  - All models use 24 directions, 25 frequencies, run on 00z, 06z, 12z and 18z cycles with 6 hour hindcasts for continuity (Sept. 2002).

http://polar.ncep.noaa.gov/waves



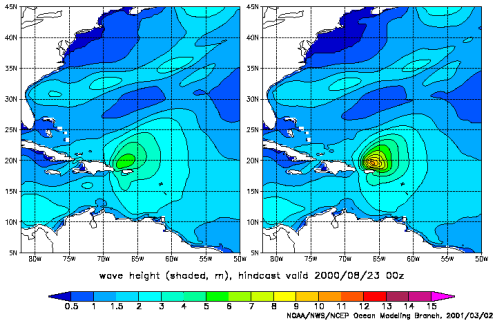
NAH versus WNA

- Why do we need a special Hurricane version (NAH) of the Western North Atlantic model (WNA)?
  - Wave model can only be as good as the winds that drive it.
  - Hurricane winds are not done particularly well by the GFS due to resolution problems and due to limitations of the model physics.
  - Better results expected when higher resolution models are used such as the GFDL model.
  - Need for blended GFS/GFDL winds.

http://polar.ncep.noaa.gov/waves

Debby significant wave height (m)
2000/08/22 00z

AVN winds | AVN + GFDL winds



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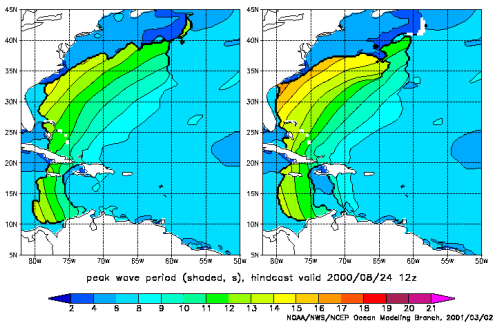
Debby peak wave period (s)
2000/08/23 12z (+ 36 h)

AVN winds | AVN + GFDL winds



Quality of Guidance

- There is a large amount of validation data available at the web. :
  - Several statistics per month / season against buoys or satellite observations. Starting Feb 1997 for global model, Aug. 2000 for regionals.
  - Results of a six-month comparison with old operational global model including a large number of time series plots.

http://polar.ncep.noaa.gov/waves/validation.html

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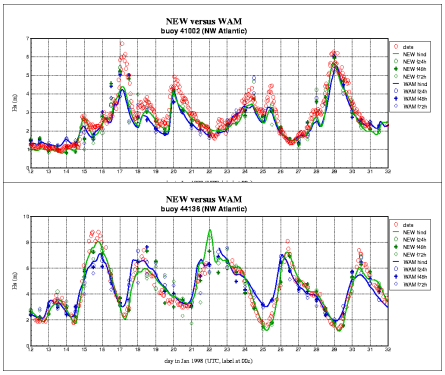
Atlantic Ocean



Quality of Guidance

- Strong points :
  - Very similar to WAM in wind seas, better in swells.
- Weak points :
  - Small scale systems not always sufficiently resolved (near-coast resolution).
  - Initial growth (East Coast).
- It is only a model, and can be only as good as its driving forces, i.e., the wind.

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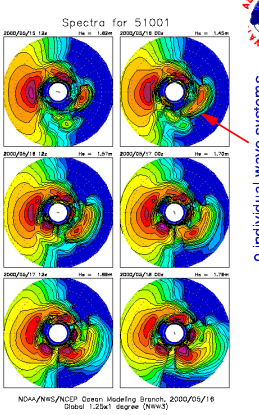
Products (what)

- Mean wave parameters in GRIB format
  - Overall significant wave height.
  - Mean direction and period.
  - Peak direction and period.
  - Wind sea direction and period.
  - NOT AVAILABLE : swell height and direction
- Text bulletins with different wave systems for output locations.

There is rarely just one swell field. What is the meaning of "the" swell height and the mean swell period and direction?



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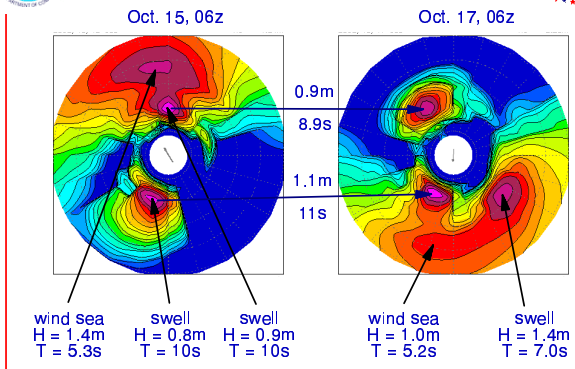

Products (where) 1

- The present model has limited distribution of products through DIFAX and AFOS. These products can be viewed using AWIPS and will be maintained as long as needed.
- Global model fields are available in AWIPS 4.3.1. Errors in AWIPS graphics near coast. Presently only up to 72 hour forecast (?).
- The regional model fields have finally become available in AWIPS 5.2 and seem to have similar problems near the coast as found in the global model.

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Products (where) 2

- Text bulletins are on AWIPS in version modified for the use of WFOs..
- ALL model data availble on the web, usually within 1 hour of the model run.
- Historical hindcast data available on web.
- We will work with any WFO or region to get products out as needed,

http://polar.ncep.noaa.gov/waves
http://polar.ncep.noaa.gov/NEW.waves

Future plans

- Extending forecast horizon to 7 days for global and WNA models (2003), beyond 3 days for NAH model.
- Additional products (swell, steepness) will be considered without firm plans or time lines (MPC!, WFO?).
- Physics upgrades are making good progress, no tentative date for implementation yet.
- We started planning for a multiscale wave model, where resolution increases near the coast, and around hurricanes. Thus a single model would replace the present set of global and regional models in about five years,

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Finally ....

For questions, remarks, requests etc., contact us at

NCEP.EMC.waves@NOAA.gov

This E-mail will be distributed automatically among our entire wave staff, and therefore will give you the fastest response. To get me personally, try

Hendrik.Tolman@NOAA.gov